NASA TECHNICAL TRANSLATION NASA TT F-15,823

PREDICTING RESISTANCE TO G-FORCES BY THE AID OF A DECOMPRESSION FUNCTIONAL TEST

V. G. Voloshin, P. M. Suvorov, A. R. Kotovskaya and R. A. Vartbaronov

Translation of: "Prognozirovaniye Ustoychivosti k Peregruzkam s Pomoshch'yu Dekompressionnoy Funktsional'noy Proby," Voyenno-Meditsinskiy Zhurnal, No. 5, May 1974, pp. 56-59

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 JULY 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F-15,823

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle

PREDICTING RESISTANCE TO G-FORCES BY THE AID OF A DECOMPRESSION FUNCTIONAL TEST

5. Report Date JULY 1974

6. Performing Organization Code

7. Author(s)

V. G. Voloshin, P. M. Suvorov, A. R. Kotovskaya and R. A. Vartbaronov

8. Performing Organization Report No.

9. Performing Organization Name and Address

Techtran Corporation P.O. Box 729
Glen Burnie, Maryland 21061

10. Work Unit No.

11. Contract or Grant No. NASw-2485

12. Sponsoring Agency Name and Address

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

13. Type of Report and Period Covered

Translation

14. Sponsoring Agency Code

15. Supplementary Notes

Translation of: "Prognozirovaniye Ustoychivosti k Peregruzkam s Pomoshch'yu Dekompressionnoy Funktsional'noy Proby," Voyenno-Meditsinskiy Zhurnal, No. 5, May 1974, pp. 56-59

16. Abstract

An examination of the suitability of a method of decompressing the lower half of the body for the purpose of determining pilot's resistance to positive g-forces. Data are introduced on the correlation between resistance to positive g-forces and findings of the decompression studies. It is found that decompression can serve as a good method of determining resistance to g-forces if some shortcomings are eliminated and a further study is made for the exact degree of coincidence of resistance levels according to the two methods.

17. Key Words (Selected by Author(s))

18. Distribution Statement

Unclassified-Unlimited

19. Security Classif. (of this report) Unclassified

20. Security Classif. (of this page) Unclassified

21. No. of Pages 8

22. Price

NASA-HQ

PREDICTING RESISTANCE TO G-FORCES BY THE AID OF A DECOMPRESSION FUNCTIONAL TEST

V. G. Voloshin[1], P. M. Suvorov[2], A. R. Kotovskaya[3] and R. A. Vartbaronov[4]

The basic goal of this study consisted in clarifying the diagnostic value /56* of the functional test with decompression of the lower half of the body (DLHB) for predicting the resistance of the pilot to the effect of g-forces in the "head to seat" direction ($+G_z$). For this purpose the results of individual tolerance to g-forces in the centrifuge and to DLHB obtained in 3 series of investigations carried out on 89 subjects ranging in age from 18 to 40 were compared.

In the first series, young, practically healthy men (32) who did not fly and ranged in age from 20 to 25 participated. Individual resistance to DLHT was determined in the sitting position of a test device built by V. G. Voloshin. The decompression value was 70 mm Hg, duration of exposure with good tolerance did not exceed 10 minutes. All subjects, as a rule, went through a repeat examination after 3-5 days. Twenty-four pilots participated in the second series; this group included 11 with deviations in the state of health (primarily vegetative-vascular deficiency or fainting in anamnesis), and these men were recognized in the medical attestation as being unsuited for flight operations in fighter aviation. The investigations were carried out on older persons (25--40); exposure to DLHB was primarily one time. The interval between exposures to DLHB and g-forces did not exceed two days. In the third series of investigations, decompression was 50 mm Hg. The experiments were set up in a mixed group consisting of 18 fighter pilots (8 of them recognized as unsuited to flight operations in fighter aviation), and 15 nonpilots. The duration of exposure with good tolerance to DLHB reached 20 minutes.

---

[1]Candidate of Medical Sciences, Lieutenant Colonel, Medical Service.
[2]Doctor of Medical Sciences, Colonel, Medical Service.
[3]Doctor of Medical Sciences.
[4]Candidate of Medical Sciences, Lieutenant Colonel, Medical Service.
*Numbers in the margin indicate pagination in the foreign text.

In the second series with exposure to DLHB, the experiment was immediately terminated if subjective or objective signs of decompensation of function appeared (hyperhydrosis, paleness of the face, hypotension, relative bradycardia, etc.). In certain cases, short term fainting and disruption of the cardiac rhythm up to transient asystole were observed following decompression of 70 mm Hg. Resistance to positive accelerations were determined after a method identical for all series (P. M. Suvorov, 1969). For revealing the objective criteria of tolerance to DLHB and g-forces, different methods of investigating the circulatory system and the optic analyzer were employed (recording the ECG and pneumogram, determining the reaction time to light and the acuity of vision, arterial pressure in the blood vessels of the concha auriculae, the shoulder, etc.).

During the statistical processing of the obtained results, methods of alternative and correlation analysis were employed (Sepetliyev, 1968). The individual data of tolerance to DLHB and g-forces were preliminarily ranked in accordance with a two to three point evaluative scale. Here the scale for evaluating resistance to g-forces coincided with one suggested earlier (P. M. Suvorov, 1969). The scale for evaluating resistance to DLHB was calculated by the aid of a special method of mathematically processing the entire body of factual material. For this purpose, the percentage of comparisons in different temporal criteria is calculated for each series (with an accuracy up to one minute), with respect to the criteria for ranking the estimates. In the capacity of criteria, values were employed at which the percentage of matches were maximum. The primary criteria for estimating resistance to DLHB and g-forces ($+G_z$) are shown in Table 1.

From Table 1 one can see that the temporal criteria for estimating resistance to DLHT in the different series significantly differ from each other (6.3 and 8 minutes). If for the third series this characteristic is explained by a decrease in the value of the physical stimulus, then for the second, apparently a decisive role is played by the intragroup differences. A comparison of the tolerance to DLHB and g-forces in the first series demonstrated the presence of a reliable correlational relationship between these tests: the coefficient of rank correlation was 0.79 ($P < 0.001$). The correlational relationship was easily detected according to the individual data as well, using the graphic method (see the Figure). The results of the initial (one time) examinations proved less reliable: the coefficient of rank correlation was 0.43 ($P < 0.05$).

TABLE 1.

Blank value	Estimate of resistance	Maximum tolerable value of g-forces in units	Time of tolerance to DLHB in min.		
			First series (-70 mm Hg)	Second series (-70 mm Hg)	Third series (-70 mm Hg)
1	Diminished	Less than 5	Less than 6	Less than 3	Less than 8
2	Good	5—6	6- 10	3—10	8 - 20
3	High	7 or more	10 or more	—	—

Note: The maximum value of g-forces, at which visual disorders were absent for a period of 30 seconds, was considered the maximum tolerable one. In the second and third series of investigations there were no subjects highly tolerant to g-forces.

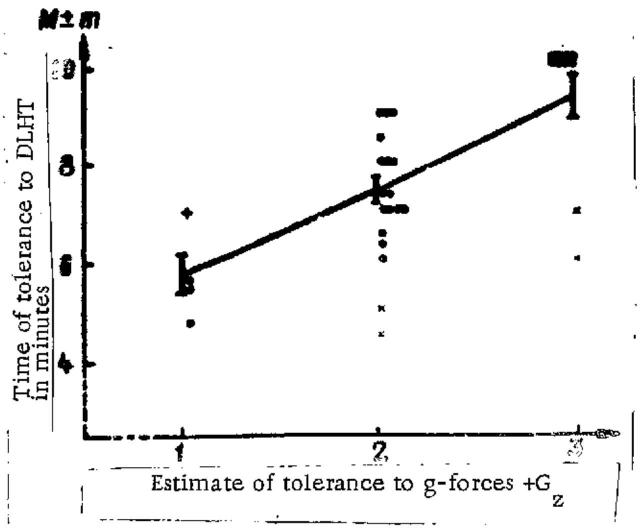
Hence, the correlation analysis demonstrated the principal capacity of using the decompression test for predicting resistance to positive g-forces. However, the absence of a total coincidence of results of examining the tolerance to DLHB and g-forces makes it necessary to determine the diagnostic value (accuracy) of the suggested method. Here, it becomes extremely important to establish the probable diagnostic error (in percentages). /58

We hypothesized that the diagnostic value of the decompression test should be determined by the percentage of coincidences and calculated according to the Fisher formula for the probability of diagnostic error. For this purpose, a two point estimate scale was employed in which persons with good and high resistance were combined in a single subgroup. During the analysis, resistance to g-forces and estimates of two types were borne in mind: the first according to the data of a one time examination, and the final one according to the data of multiple examinations. In the latter case, the best result was obtained with the exception of those observations in which repeated examination led to a significant decrease in tolerance to DLHB or g-forces. In these cases, one more additional examination was carried out where the mean time was used (DLHB). The frequency of coincidences of estimates of tolerance to DLHB and g-forces ($+G_z$), as well as the probable diagnostic error of the decompression test are shown in Table 2.

TABLE 2.

Group of subjects	First series (-70 mm Hg) First estimate: No. of cases	% of coincidences	Statistical probability of error in %	First series (-70 mm Hg) Final estimate: No. of cases	% of coincidences	Statistical probability of error in %	Second series (-70 mm Hg): No. of cases	% of coincidences	Statistical probability of error in %	Third series (-50 mm Hg): No. of cases	% of coincidences	Statistical probability of error in %
Not resistant to g-forces	8	62,5	10—71	4	75	0—72	12	41,7	31—84	13	23	51—85
Resistant to g-forces	21	71,4	12—50	28	92,9*	1—19	12	83,3	2—42	20	75	9—46
Whole group	29	69	12—49	32	90,6*	2—21	24	62,5	20—57	33	54,5	29—63

Note: In the second and third series of investigations, the percentage of coincidences was calculated only according to the first estimate. The level of significance *(P < 0.01) was determined by the aid of sign criteria. The statistically probable error was calculated according to the Fisher formula.
Commas indicate decimal points.



The Correlation Between Estimates of Resistance to G-Forces and Time of Tolerance to DLHB in the First Series of Investigations. The coincidence of estimates are indicated by periods and deviations are indicated by crosses.

In examining the data of Table 2 it is vital to bear in mind that with independent (varied probability) distribution of values of resistance to DLHB and g-forces, the percentage of coincidences (or probability of diagnostic error) is theoretically 50%. In this case the diagnostic value of the test is zero. Proceeding from the indicated concepts, satisfactory results were obtained in the first series of investigations only according to the final estimate among persons resistant to g-forces. Actually, it was only in this group that the value of actual diagnostic error was 7.1% with a maximum expected error (with a probability of 0.95) of no more than 19%. When analyzing the data, the quite high percentage of coincidences among subjects resistant to g-forces in the remaining series of investigations as well attracts attention. Here, however, the level of expected maximum diagnostic error approaches 50%. With respect to a group of persons not resistant to g-forces, one should note the significant value and dispersion of expected diagnostic errors falling within limits of random fluctuations (±50%).

In analyzing the material of Table 2, one can see that the DLHB test with decompression of 50 mm Hg for 20 minutes (third series) is uninformative for estimating resistance to g-forces in the cranio-caudal direction, in connection with the nearly equiprobable distribution of estimates. Only the two time DLHB test with decompression of 70 mm Hg is suitable for diagnostic goals; this test makes it possible significantly to increase the percentage of coincidences and to decrease the probability of maximally expected diagnostic errors to 19%. A comparison of the levels of diagnostic error in groups of persons with varying resistance to g-forces makes it possible to hypothesize that the use of the functional DLHB test in flight-surgical practice entailed screening out a certain number of pilots resistant to the effect of g-forces. In certain cases, persons were also being admitted to flight duty who are not resistant to $+G_z$ g-forces. /59

The practical application of DLHB as a functional test is possible after solving certain additional problems. It is necessary to verify the temporal criteria for estimating resistance to DLHB, to increase the reliability and safety of investigations, and to develop adequately simple instrumental methods of operational medical control. Finally, additional investigations are required to increase the diagnostic accuracy of the test, particularly with respect to persons not resistant to g-forces. Subsequent investigations in this regard should be considered justified since the promise of employing the DLHB method with the goal or predicting pilot resistance to the effect of $+G_z$ g-forces is justified.

Conclusions

1. The principal possibility of using the functional test with decompression of the lower half of the body (DLHB) is established for predicting the resistance of a fighter pilot to the effect of positive ($+G_z$) g-forces.

2. The diagnostic value of the DLHB test for estimating resistance to g-forces proved to vary depending on repeated exposure, the contingent of subjects and the modes of decompression.

3. Two time examination of young, practically healthy people who did not fly, with decompression of the lower half of the body of 70 mm Hg in the sitting position revealed a high percentage (90.6%) of coincidences of the estimates of tolerance to DLHB and positive g-forces.

4. One time examination with DLHB among persons not of flight professions (decompression of 70 mm Hg) and of fliers, particularly with deviations in the state of health (decompression 70 and 50 mm Hg) did not reveal a significant correlation between tolerance to DLHB and positive g-forces.

Translated for the National Aeronautics and Space Administration under Contract No. NASw-2485 by Techtran Corporation, P.O. Box 729, Glen Burnie, Maryland, 21061.